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Neonatal Hearing Screening

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■ *Auditory testing of neonates has received considerable attention in the last few years. As a result, several machines have been devised for this type of evaluation. It has been proposed that this equipment can be utilized by volunteer personnel to assess the hearing of infants. This investigation indicates that even trained audiologists are unable to make a definitive estimate of the hearing level in many newborns.*

OTOLOGISTS AND AUDIOLOGISTS have long been intrigued by the possibility of screening newborns for hearing. Proponents of routine mass screening cite two main reasons: Early diagnosis of hearing loss is a prerequisite for effective rehabilitation, and the newborn period offers a unique opportunity to work with a "captive audience" in hospital nurseries.

Investigators have generally dealt with two classes of response—physiological and behavioral. For determining physiological response, testers note the effects of a sound stimulus on heart rate,[1] respiration,[2] and electroencephalogram tracings.[3] At first glance, such measurements may appear reassuringly objective. Question arises, however, as to whether measured changes constitute a response to the sound stimulus, or a response to the many internal stimuli operating in the neonate. Hardy[4] noted that the newborn sleeps approximately 22 out of every 24 hours, making it difficult if not impossible to catch him in an optimal state for testing.

Similar problems arise with the use of behavioral responses. Several studies have used gross behavior as response: Moro reflex, eyeblink, crying, cessation of crying and body movement.[5-12] Again, investigators must take neonatal instability into account. Certainly, without follow-up, it can only be said of the infants who "failed," merely that they did not respond to the stimulus.

Most published studies in the neonatal period have done little or nothing with follow-up. One exception was the study done by Hardy et al[4] as part of the Collaborative Perinatal Project of 2000 infants. The criterion for hearing was a reflex startle response or some modification. In follow-up studies, Hardy found no positive relation between passes and failures and subsequent development of communication; and he concluded that testing during the neonatal period was without merit.

The personnel to be used as observers poses another problem in neonatal testing. One univer-

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sity medical center uses "trained volunteers."[6,7] Another university-affiliated center advocates the use of "qualified audiologists" with three months' experience with newborns.[11] A report from a large hearing and speech center says that nurses, residents, or other physicians already working in the hospital nursery can be trained in a relatively short time to test the hearing of newborns routinely.[10]

Whoever the observers, they are subject to certain bias variables. Eisenberg[13] cited the effects of observer position in relation to the infant and also observer fatigue as gauged by the number of infants studied and the time of day. A recent study by Ling et al[14] supports Eisenberg's contention that observers exposed to an audible stimulus are biased toward judging any behavioral changes as response.[15]

In the past five years, the Hearing and Speech Clinic at Childrens Hospital of Los Angeles has had many queries concerning the desirability of setting up neonatal hearing screening programs in hospitals in the community. Because Childrens has no newborn nursery we had no experience in this field, and were further discouraged by our perusal of the literature.

We therefore welcomed the invitation by a staff neonatologist to do an exploratory project in a nearby hospital. We were granted permission to screen the newborns in the nursery without obtaining permission from individual physicians and without entering the results in charts.

At the outset, a number of questions were posed:

1. Can responses to an external stimulus—that is, sound—be reliably differentiated from responses to the many internal stimuli operating in the neonate?
2. What personnel should be used for testing?
3. How predictive are responses or non-responses in the newborn period?
4. Does the statistic that 1 in 2000 children is born with a hearing loss justify the time and expense necessary for setting up such a screening program?

Method

The population for the exploratory study consisted of 521 neonates ranging in age from a few hours to four days. Babies weighing less than 5½ pounds were considered premature and hence were not included. The test group appeared to be a representative cross-section of all socio-economic groups in the community.

On the basis of comparative studies of available screening instruments done under sponsorship of the California State Department of Health,[10] the Vicon Apriton was selected as the most satisfactory instrument. It has a broad band response from 100 through 6000 Hz, and a 3000 Hz tone. The intensity of both the broad band response and pure tone can be set at 70, 80, 90, and 100 decibels (dB).

Each infant was tested in his own bassinet in a far corner of the nursery away from the other infants. The speaker was held approximately 12 inches from the ear, and the sound presented for about 5 seconds (beginning with the broad band sound at 90 dB). Two observers made independent judgments of any response—its type and strength, the area of the body in which it occurred, and the pre-test state of the infant. Responses were not counted as such unless noted by both observers. Except for the eye-blink and the Moro reflex, behavior had to be repeatable in order to be considered a response. If there was no response to either the broad band or 3000 Hz tone at 90 dB, the intensity was increased to 100 dB.

To assess predictability, follow-up seemed a crucial part of the study. It appeared important to check for false negatives as well as for false positives. Hardy[4] cited certain conditions, among them anoxic brain damage and hyperbilirubinemia, that may not show their effects on hearing on the first or second day of life.

Parents of babies seen as neonates were invited to come to Childrens Hospital for a more definitive hearing evaluation when their babies were between three and four months old.

Results

Of the 521 neonates, 181 (35 percent) did not have response, by our criteria, to the screening in the nursery. The problem of discriminating between responses to sound and responses to various other stimuli proved to be a very real one. A hungry baby was so concerned with his animal desire for food that he rarely responded to the stimulus. Several subject variables were closely related to the incidence and type of response. Many of the non-responders, for example, had vernix caseosa still visible in the ear. The pre-test

state of the infant seemed to affect the nature of the response. The intensity of the response tended to decrease as the arousal of the infant increased. At the same time, we were impressed with the depth of sleep in many of our non-responders.

An attempt was made to correlate lack of response with various prenatal, perinatal, and postnatal factors, such as Rh-negative mother, heavy anesthesia during delivery, low Apgar ratings, cesarean sections, and respiratory distress during the first few hours of life. Examination of the charts revealed no general trends. Such factors tended to be evenly scattered between babies who responded and babies who did not.

In order to assess any factors which might be related to that particular nursery, permission was obtained to screen an additional group in a larger nearby hospital. Time did not permit screening a comparable sized group, but when 113 babies were tested a higher failure rate than reported by other investigators continued to emerge. From the total population of 634 subjects, 200 (32 percent) failed the screening.

Of the original 521 neonates, 147 were seen again between the ages of three and four months. They were tested in a sound field using voice and warbled pure-tone bursts from 500 Hz through 3000 Hz as stimuli. Of the 147, 145 passed without question, although 51 of these infants had failed in the nursery. There was some question about the responses of two babies, and they are being followed.

Five observers were used during the course of this project: two audiologists—one trained and experienced, the other trained and inexperienced; two graduate students in audiology; and one trained and experienced speech pathologist. Personnel trained in observation of hearing and speech are usually handicapped by a lack of experience with newborns, and need a period of practice observation. But after a month's practice there was still considerable disagreement among the observers as to type and strength of response. The situation could only be confounded by using volunteers.

Recommendations

On the basis of our experience, we cannot recommend a hearing screening program as a routine measure with a newborn population. The high number of false positives, together with the statistic that 1 in 2000 children is born with a hearing loss, convince us that this is not a useful clinical procedure.

It is quite likely that our number of failures would have been sharply reduced had we gone back to re-test several times during the same day, or the next, or even taken the infant to a sound room to stimulate further. A screening program in operation in a university medical center does follow such a procedure. For the average community or small private institution, however, it is not feasible. While the cost of the equipment is not exorbitant, a great deal of professional time is necessary to conduct the program properly.

The lack of correlation between no response and various "suspect" factors indicates that there are subject variables operating in a newborn population which must be clearly defined before we can make assumptions based on gross behavioral observations. Proponents of mass neonatal screening argue that the newborn period creates a "captive audience" and is therefore the most logical time for diagnosis. More to the point, perhaps, is the questionable value of investigating the neonate routinely in any way.

In summation, we concur with a statement published by the American Academy of Ophthalmology and Otolaryngology in the *Perceiver* for December, 1970:

> Review of data from the limited number of controlled studies which have been reported to date has convinced us that results of mass screening programs are inconsistent and misleading.

The academy goes on to say that it recognizes the need for the early detection of hearing impairments, but cannot recommend routine screening of newborns in the present state of the art. It urged, instead, increased research. The same sentiments were expressed by the American Academy of Pediatrics in the *Newsletter* of January, 1971, and by the American Speech and Hearing Association in *ASHA* of January, 1971.

If a valid and reliable technique for neonatal screening is found, a high-risk register can be used to locate infants whose hearing may be suspect at birth. In the meantime, the physician who comes into contact with the child during the first year of life is urged to look for indications of hearing loss. It is crucial that he have the right questions to ask the parents. He must learn to listen to the comments and descriptions of behavior made by mothers which might be signs of

abnormal hearing. Recently, a mother took her 11-month-old infant to an audiologist because she had come to notice that whenever she changed the baby's diaper he imitated her facial expressions but not her voice. This mother made a valid observation: her child did indeed have a hearing loss. Observations such as this remain a much more reliable diagnostic tool than any screening techniques yet available.

REFERENCES

1. Bartoshuk AK: Human neo-natal cardiac acceleration to sound: Habituation and dishabituation. Percept Mot Skills 15:15-27, 1962
2. Heron TG, Jacobs R: A physiological response of the neonate to auditory stimulation. Int Audiol 7:41-47, 1968
3. Long V, Hilger JA, Roth NA: The objective evaluation of auditory function. Lancet 87:251-255, 1967
4. Hardy JB: Studies of hearing in neonates, *In* The Young Deaf Child: Identification and Management. Acta Otolaryngol (Suppl) 206:34-36, 1965
5. Birns B, Blank M, Bridger WH, et al: Behavioral inhibition in neonates produced by auditory stimuli. Child Dev 36:639-645, 1965
6. Downs MP, Sterritt GM: A guide to newborn and infant hearing screening programs. Arch Otolaryngol 85:15-22, 1967
7. Downs MP, Sterritt GM: Identification audiometry in neonates: A preliminary report. J Aud Res 4:69-80, 1964
8. Field H, Copack C, Derbyshire AJ, et al: Responses of newborns to auditory stimulation. J Aud Res 7:271-285, 1967
9. Fröding C: Acoustic investigation of newborn infants. Acta Otolaryngol 52:31-40, 1960
10. Reddell RC: Should your hospital test newborns' hearing? Hospital Practice 107-110, Feb 1970
11. Rosenberg P, Lovrinic J, Katinsky S, et al: Some observations on neonatal hearing screening. Paper presented at ASHA conference, Nov 1969
12. Suzuki T, Kamijo Y, Kiuchi S: Auditory test of newborn infants. Ann Otol Rhinol Laryngol 73:914-923, 1964
13. Eisenberg RB: Auditory behavior in the human neonate: A preliminary report. J Speech Hear Res 7:245-269, 1964
14. Ling D, Ling AH, Doehring DG: Stimulus, response, and observer variables in the auditory screening of newborn infants. J Speech Hear Res 13:9-18, 1970
15. Eisenberg RB: Auditory behavior in the human neonate: Methodological problems and the logical design of research procedures. J Aud Res 5:159-177, 1955

HEART ATTACKS AFTER OPERATION

What are the odds of developing a heart attack before or shortly after anesthesia and surgery?

If you've never had a heart attack before, you stand about a one percent chance or less of developing one. In other words, you're no more likely to develop an attack with surgery than without it. If you do get a heart attack, the mortality rate is about 25 percent.

If you have had a previous heart attack, the probability of developing another one (either during the operation or in the first few days afterward) is six or seven times as great. If you have another attack, you're very likely to die of it. There's a 70 percent mortality instead of a 25 percent mortality.

The important factor seems to be the interval of time which elapses between the previous heart attack and the surgical operation. If the interval of time is very short, a matter of a few months, then the chance is very high that he is going to get a second heart attack. Often during recuperation from a heart attack the patient is advised to take a holiday. He may go away to a nice sunny place and then return home a month later the picture of health—bronzed and having put on a bit of weight. Then his doctor says, "Why don't you have those piles or that hernia taken care of before you go back to work?" The patient goes into the hospital to have a straightforward operation, gets his second coronary, and dies of it.

As the interval between the heart attack and the surgery is extended, the likelihood of another attack decreases. If the interval is as long as two to three years, the risk is probably no higher than if the patient had never had a heart attack at all.

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